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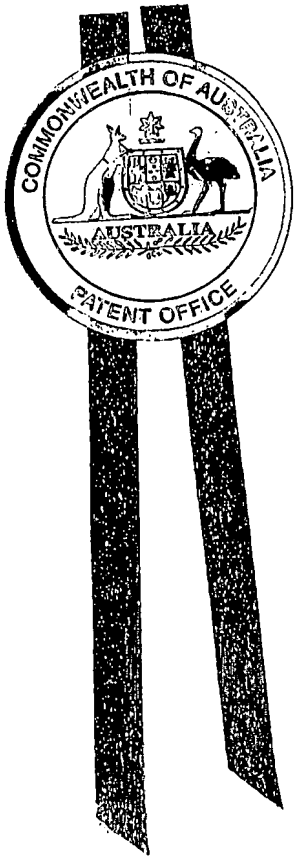

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Fourteenth day of January 2005

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IMPROVEMENTS IN OR RELATING TO EMISSION CONTROL SYSTEMS

Field of Invention

This invention relates to methods and means for controlling emissions from internal combustion engines, and is particularly directed to a method and apparatus to control the temperature of the catalytic converter in an exhaust flow. The invention may be applicable to any type of internal combustion engine but will typically find best application in engines which operate between an idling condition and a revving condition. The invention may find particular application with smaller engines such as lawnmower engines, engines used on line trimmers, chainsaws, and other types of small powered tools, motorcycle engines, car engines, marine engines and the like.

Background Art

The main emissions of combustion engines are:

- **Nitrogen gas** (N2) - Air is 78-percent nitrogen gas, and most of this passes right through the car engine.
- **Carbon dioxide** (CO2) - This is one product of combustion. The carbon in the fuel bonds with the oxygen in the air.
- **Water vapor** (H2O) - This is another product of combustion. The hydrogen in the fuel bonds with the oxygen in the air.

These emissions are mostly benign (although carbon dioxide emissions are believed to contribute to global warming). But because the combustion process is never perfect, some smaller amounts of more harmful emissions are also produced in car engines:

- **Carbon monoxide** (CO) - a poisonous gas that is colorless and odorless
- **Hydrocarbons** or **volatile organic compounds** (VOCs) - produced mostly from unburned fuel that evaporates
- **Nitrogen oxides** (NO and NO2, together called NOx) - contributes to smog and acid rain, and also causes irritation to human mucus membranes

These are the three main regulated emissions, and also the ones that

catalytic converters are designed to reduce.

Modern cars are equipped with two-way and three-way catalytic converters. This means that they aim to reduce three types of emissions (listed above). CO,VOCs,NOx

The converter uses two different types of catalysts, a **reduction catalyst** and an **oxidization catalyst**. Both types consist of a ceramic structure coated with a metal catalyst, usually platinum, rhodium and/or palladium. The idea is to create a structure that exposes the maximum surface area of catalyst to the exhaust stream, while also minimizing the amount of catalyst required (they are very expensive).

There are two main types of structures used in catalytic converters -- **honeycomb** and **ceramic beads**. Most cars today use a honeycomb structure.

The **reduction catalyst** is the first stage of the catalytic converter. It uses platinum and rhodium to help reduce the NOx emissions. When an NO or NO2 molecule contacts the catalyst, the catalyst rips the nitrogen atom out of the molecule and holds on to it, freeing the oxygen in the form of O2. The nitrogen atoms bond with other nitrogen atoms that are also stuck to the catalyst, forming N2. For example:

$$2NO \Rightarrow N_2 + O_2 \text{ or } 2NO_2 \Rightarrow N_2 + 2O_2$$

The **oxidation catalyst** is the second stage of the catalytic converter. It reduces the unburned hydrocarbons and carbon monoxide by burning (oxidizing) them over a platinum and palladium catalyst. This catalyst aids the reaction of the CO and hydrocarbons with the remaining oxygen in the exhaust gas. For example:

$$2CO + O_2 \Rightarrow 2CO_2$$

It is well-known to provide catalytic converters in the exhaust stream of vehicles such as cars and trucks, and in many countries catalytic converters are now compulsory.

It is known to position the catalytic converter in different places in the exhaust stream and it is known to position the catalytic converter before a muffler, after a muffler and the like.

It is known to provide an exhaust system containing a catalytic converter where the exhaust system is designed in a particular manner to reduce noise emissions. It is known to provide an exhaust system having a particular flow pathway to ensure that all the gases "bathe" the catalyst for better conversion. It is known to

attach the catalyst to the muffler outlet of a lawnmower engines to reduce emissions. It is known to provide a catalytic converter with a spiral muffler which finds particular use in small internal combustion engines to create a venturi effect.

To operate efficiently, catalytic converters need to reach and maintain certain temperatures and in some operating conditions when an engine is idling or when a vehicle is in stop/start traffic, temperatures fall off making the converters inoperable or lessening the efficiency of same. Typically, the catalytic converter needs to be kept quite hot in order in order to work efficiently and the converter is kept at a high-temperature by the hot exhaust gases. However, when the engine is idling the volume of the exhaust gases is less and therefore less heat passes over the catalytic converter. If the engine revolutions are suddenly increased, there may be a lapse of time before the catalytic converter can be sufficiently heated by the exhaust gases to work efficiently. Therefore, there is a disadvantage and an operational inefficiency with the use of conventional catalytic converters in engines and especially smaller engines that often pass from an idling condition to a high revving condition

It is a general objective of the present invention to provide methods and apparatus for reducing emissions from internal combustion engines.

Further objects and advantages of the present invention will become apparent from the ensuing description.

Disclosure of Invention

In one form, the invention resides in a method for reducing emissions from an internal combustion engine of the type which has an exhaust stream, the method comprising providing a catalytic converter in the exhaust stream, and providing a valve which is operable between and open position and a closed on partially closed position, the valve being downstream from the catalytic converter and functioning to increase the resident time of the exhaust gas about the catalytic converter especially when the engine is idling.

Thus, when the engine is idling, the valve may be in a closed or partially closed position to keep the hot exhaust gases in the exhaust stream and about the catalytic converter to keep the temperature of the catalytic converter higher than would otherwise be the case if the exhaust gases were simply allowed to pass through the exhaust system unencumbered.

The method may comprise a single valve as described above or a plurality of valves. If a plurality of valves is provided, these may be in "series" in "parallel" or in any combination thereof.

The valve may be provided downstream of the catalytic converter to throttle or choke the exhaust gases when necessary to ensure that the catalytic converter is kept at a high temperature than otherwise would be possible. It is envisaged that the valve can be positioned at any position downstream of the catalytic converter including immediately behind the catalytic converter, or some distance away from the catalytic converter, or even external of the exhaust pipe.

It is envisaged that no particular limitation should be placed on the type of valve that may be used. Therefore, the valve may comprise a simple hinged flap valve, a slide valve, a rotating valve, a waste gate and the like.

It is preferred that the valve is operated such that will move to a more open position or a fully open position upon an increase of the volume of exhaust gases passing through the exhaust system. For instance, it is preferred that the valve move to a more open position when the engine revs at higher resolutions as sufficient hot gases now pass over the catalytic converter. It is preferred that the valve is operable in an automated or semi-automated manner. In a very simple form, the valve may comprise a hinged weighted valve, which move under the influence of gravity to a closed position when the engine gas volume is low but which is pushed by the engine gas volume to an open position when the gas volume is higher. Alternatively, the valve may be spring biased to a naturally closed position and can be pushed into an open position by the volume of the engine gas. Alternatively, the valve may be operated by temperature and may move from a closed position to an open position upon an increase in the temperature. This type of valve may be called a "thermostat valve". Alternatively, the valve may be operated by pressure differential in the exhaust stream. Other types of operating means to operate the valve may be used.

According to the broadest aspect of the present invention, there is provided a method of reducing emissions from an internal combustion engine including the step of positioning a catalytic converter in an exhaust system downstream of a muffler in the system.

The catalytic converter may be installed in a system which includes a further catalytic converter upstream of the muffler.

The catalytic converter may include an elongate metal tube housing a honeycomb structure.

The catalytic converter may form the end section of an exhaust system or be interposed between a muffler and the end section of an exhaust system.

In an application of the present invention to small engines, a catalytic converter may be fitted within a tube extending from the exhaust outlet of a muffler.

The tube may extend partially into the muffler.

The end of the tube may be fitted with a deflecting baffle device.

In a further form of the present invention, a catalytic converter is positioned between the engine output and the exhaust of a marine outboard motor.

According to yet a further aspect of the present invention, there is provided a method of reducing emissions from an internal combustion engine including the step of positioning a catalytic converter in an exhaust system downstream of a muffler wherein the catalytic converter is housed within a tube, a section of which incorporates a hinged flap which is capable of varying exhaust output flow rates depending on the mode of operation of the engine.

The flap may be weighted to suit various engine types and applications.

The distal end of the tube may be raked and the flap hinged to an upper region of the tube so that it closes off the tube when an engine is not operating.

Brief Description of the Drawings

Aspects of the present invention will now be described with reference to the accompanying drawings in which;

Figure 1 is a side view of a typical catalytic converter as is known in the art and is marked "prior art" accordingly, and

Figure 2 is a diagrammatic block diagram of an emission control system as is known in the prior art, and

Figure 3 is a diagrammatic block diagram of an emission control system according to the present invention, and

Figure 4 is a perspective drawing of a catalyst device in accordance with one possible embodiment of the present invention, and

Figure 4a is a side view of a catalyst device in accordance with a further possible embodiment of the present invention, and

Figure 5 is a side view of a small motor muffler assembly having a catalytic converter, and

Figures 5a and 5b are end and sectional views of the converter of figure 5, and

Figure 6 is a side view of a small motor muffler assembly according to a further aspect of the present invention, and

Figure 7 is a side view of a further small motor assembly according to another aspect of the present invention.

Figure 8 is a diagrammatic side view of a marine outboard motor incorporating a catalytic converter in accordance with another aspect of the present invention.

Figure 9 is a side view of a fitting including a catalytic converter in accordance with a further aspect of the present invention.

Figure 10 is an end of the fitting of Figure 9.

Figure 11 is a side view of a muffler outlet including a catalytic converter in accordance with a further aspect of the present invention.

With respect to the drawings, a typical catalytic converter as is known in the art and generally indicated by arrow 1 is designed to be interposed between an engine and a muffler associated with the engine. The converter typically comprises an inlet 1, a body 3 and an outlet 4.

Within the body 2 there is provided a reduction catalyst A and oxidation catalyst B and honeycombs C.

The catalytic converter 1 is interposed between an engine 5 and a muffler 6 of the an emission system as is indicated by figure 2.

According to the present invention and as illustrated by figure 3 a further converter device 7 is positioned downstream from the muffler 6 in a system.

The following test results indicate a surprising improvement in emission outputs as a result of the positioning of a downstream converter according to the present invention.

TEST ONE

CO2 %	13.76	CO %	0.27
02 %	1.89	Eff %	98.49
Hexane Ppm	81	MRP In Hg	14.60
NOx Ppm	980	LDA —	1.08

TEST TWO

CO2 %	14.15	CO %	0.03
02 %	1.64	Eff %	99.55
Hexane Ppm	73	MRP In Hg	14.54
NOx Ppm	873	LDA —	1.08

TEST THREE

CO2 %	13.80	CO %	0.03

02 %	2.88	Eff %	99.76
Hexane ppm	25	MRP In Hg	14.75
NOx ppm	877	LDA —	1.14

TEST ONE was carried out on a system not having a catalytic converter. It is noted that of the content of exhaust emissions, the CO (carbon monoxide), Hexane (hydro carbon/unburnt fuel) and NOx (nitrogen oxides) are deemed to be undesirable pollutants. In all situations, if a system is able to reduce CO Hexane and NOx emissions CO_2 emissions will rise as a consequence.

TEST TWO was carried out on a system including a catalytic converter of minimal length positioned downstream from the exhaust. It is noted that in test two, CO_1 Hexane and NOx are reduced and CO_2 has risen marginally.

TEST THREE was carried out on a system similar to test two with a full length catalytic converter positioned downstream of the exhaust. In test three, the same CO result was obtained, a substantial reduction in Hexane was achieved and a minor change in NOx was noted.

The catalytic converter of the present invention as illustrated by figure 4 comprises a metal open ended tube of a generally circular cross-section which encloses a honeycomb core 9. The tube 8 may have one or more air vents 9.

The converter 7 may be provided in a number of lengths and widths depending on the application.

The tube 8 can be readily adapted for fitment to an exhaust pipe and in some applications e.g. smaller engines it may be fitted directly to an outlet manifold.

Figure 4a of the drawings illustrates a further form of converter according to the present invention which is frustoconical in shape. The converter is

positioned in a system as previously and can be interposed in an exhaust or produced as an add-on to the end of an exhaust. The shape of the converter increases the cross sectional area of the honeycomb core through which exhaust gases must pass.

With respect to Figure 5 of the drawings, the small muffler illustrated comprises a split casing (typically a metal casing) generally indicated by arrow 10.

An exhaust inlet 11 is positioned on a rear wall 12 of the casing.

Within the interiors of the casing, a mesh shield 13 is provided and a baffle plate 14.

Incoming exhaust fumes travel in the direction of the path arrows on the drawing and are delivered to an outlet pipe 15 which has an end cap 16.

A honeycomb core 17 is positioned within the pipe 15 and extends substantially throughout the length of the pipe.

A ring of stainless steel mesh 18 at the entry portion at the pipe assists to locate the core 17.

The cap 16 (see figures 5a and 5b) may be provided with a plurality of vents 19 which deflect exhaust downwardly.

With respect to figure 6 of the drawings, a similar small muffler is provided except that the tube 17 extends partially into the interior of the casing 10.

Figure 7 of the drawings shows a further form of muffler according to the present invention where an exhaust inlet 11 is positioned centrally in the back wall 12 and a honeycomb core 20 occupies a first approximate half-section of the casing.

A baffle plate 21 is positioned downstream of the core 20 and the exhaust path again being indicated by path arrows.

With respect to figure 8 of the drawings, a marine outboard motor generally indicated by arrow 30 is provided with a catalytic converter 31 positioned between power head 32 and an exhaust passage 33 in the bag 34.

The converter 31 may optionally be positioned at "A" between the head 32 and the passage 33 and/or at "B" within the passage 33.

In the arrangement illustrated, treated exhaust gases are deposited in open water via the passage 33 as indicated by the path arrows of figure 8.

With respect to figures 9 to 11 of the drawings, a catalytic converter is installed downstream of the exhaust muffler of a combustion engine.

In figures 9 and 10 of the drawings, a converter is provided with a

tubular body 35 which is fitted onto an end pipe 36 of an exhaust system.

The body 35 houses a catalyst 37.

The end 38 of the pipe 36 is raked and a valve in the form of a hinged flap 39 is fitted to the raked end as indicated. A suitable raking angle is approximately ten degrees.

A hinge 40 securing the flap is uppermost so that when an engine feeding an exhaust system is not running, the flap is closed.

The flap 39 may be "weighted" to suit particular installation situations.

When an engine is running at idle or road speed, the position of the flap and thus, the exhaust output varies depending on exhaust outflow.

At idle speed, the flap is partially closed restricting outflows and as a result, maintaining heat within the catalyst to ensure it is operable.

Figure 11 of the drawings illustrates a combination of a muffler 40, an end pipe 41, a catalyst 37 and a flap 39 as described in the previous embodiment.

The present invention is not only relevant to motor vehicles but also equally applicable to all engines using hydrocarbon fuels, e.g. diesel, two stroke and four stroke engines.

The significant advantage of the present invention is the reduction of undesirable output emissions for all engine types.

In the instance that the invention is applied to a small motor e.g. a lawnmower motor, the converter may be connected directly to an exhaust outlet or incorporated in a muffler device.

Aspects of the present invention have been described by way of example only and it would be appreciated that modifications and additions thereto can be made without departure from the scope of the invention. For instance although the valve is embodied as a hinged flap, the remainder of the specification makes it clear that the invention is not to be limited only to this specific embodiment and other types of valves can also be used.

DATED this 16th day of January 2004

Adrian Menzell
By his patent attorneys
Cullen & Co.

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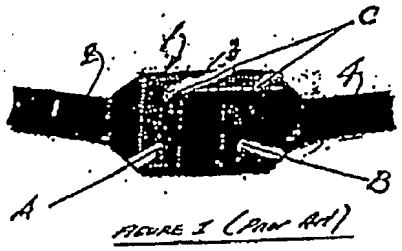

FIGURE 1 (Prior Art)

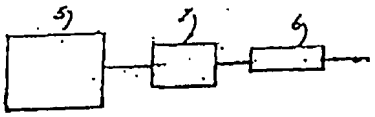

FIGURE 2 (Prior Art)

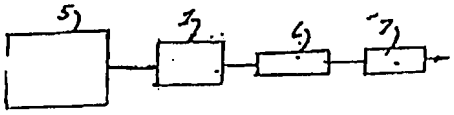

FIGURE 3

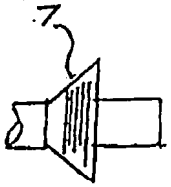

FIGURE 4a

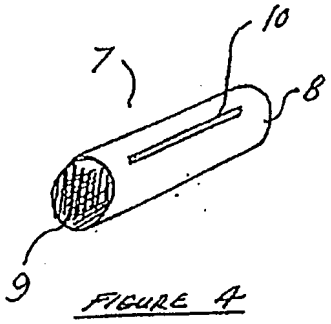

FIGURE 4

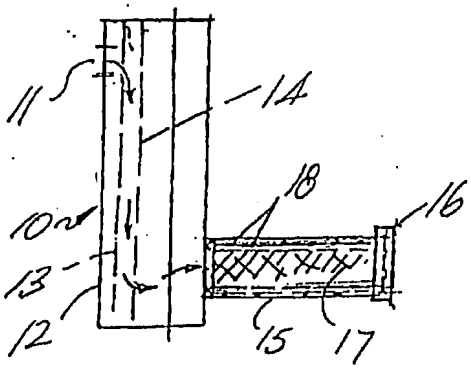

FIG.5

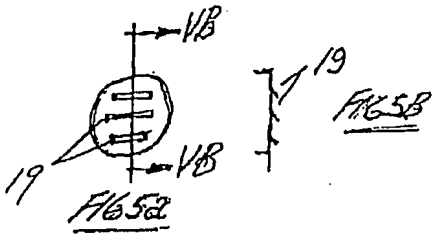

FIG5B

FIG5A

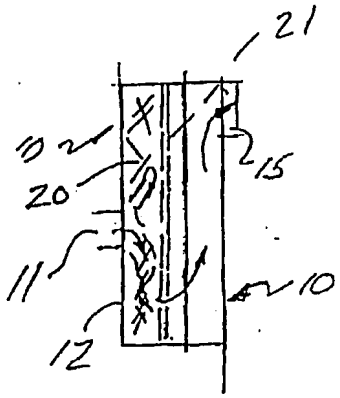

FIG 7

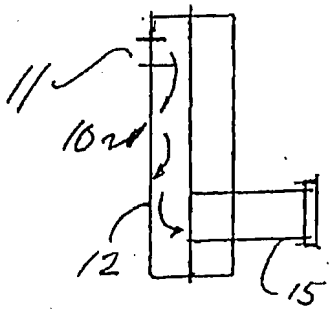

FIG. 6

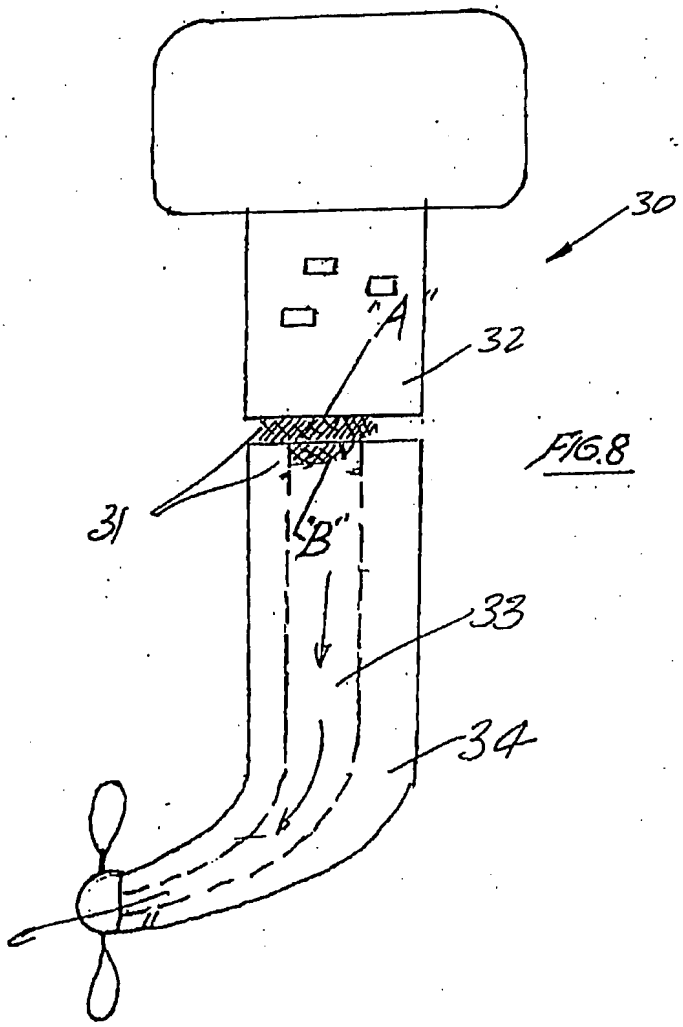

FIG.8

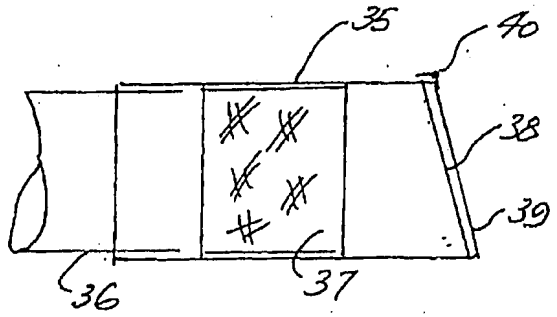

FIG 9

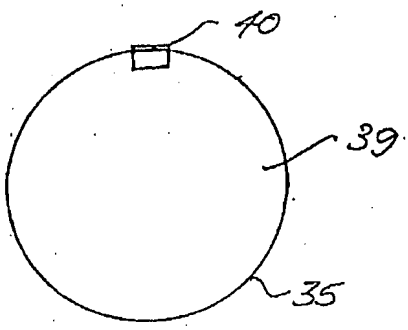

FIG 10

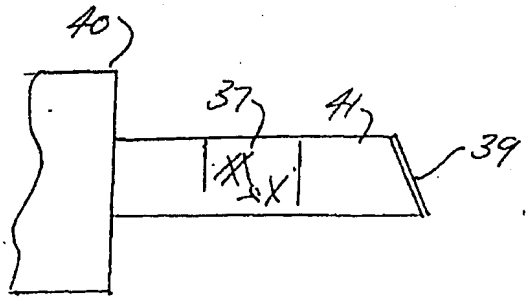

FIG 11